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Edwin H. Taylor
Blakely, Sokoloff, Taylor & Zafman LLP
Seventh Floor
12400 Wilshire Boulevard
Los Angeles, CA 90025-1030

EXAMINER	
CHEN, ERIC BRICE	

ART UNIT	PAPER NUMBER
1765	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/627,838	KLOSTER ET AL.	
	Examiner	Art Unit	
	Eric B. Chen	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *7/25/03*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-41* is/are pending in the application.

4a) Of the above claim(s) *35-41* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-19 and 21-34* is/are rejected.

7)☒ Claim(s) *14 and 20* is/are objected to.

8)☒ Claim(s) *1-41* are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-34, drawn to a method, classified in class 438, subclass 700.

II. Claims 35-41, drawn to a structure, classified in class 257, subclass 499.

2. The inventions are distinct, each from the other because of the following reasons: Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case, the structure can be fabricated without silane compounds. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper. Furthermore, because the search required for Invention I is not required for Invention II, restriction for examination purposes as indicated is proper.

3. During a telephone conversation with Edwin H. Taylor on May 10, 2005, a provisional election was made without traverse to prosecute Invention I, claims 1-34. Affirmation of this election must be made by applicant in replying to this Office action. Claims 35-41are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

4. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Priority

5. Applicant is advised of possible benefits under 35 U.S.C. 119(a)-(d), wherein an application for patent filed in the United States may be entitled to the benefit of the filing date of a prior application filed in a foreign country.

Specification

6. The use of the trademarks LKD-5109, JSR, NANOGLASS-E, HONEYWELL, ZIRKON, SHIPLEY, SILK, DOW CHEMICAL, and GX-3P has been noted in this application (Applicants' Specification, filed Jul. 25, 2003, page 5, paragraph 0020). It should be capitalized wherever it appears and be accompanied by the generic terminology. Although the use of trademarks is permissible in patent applications, the proprietary nature of the marks should be respected and every effort made to prevent their use in any manner which might adversely affect their validity as trademarks.

Claim Objections

7. Claim 14 is objected to because of the following informalities: "methoxyprpyltrimethoxysilane" apparently should be -- methoxypropyltrimethoxysilane -- ("prpyl" is missing the letter "o"). Appropriate correction is required.

Double Patenting

8. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. *See In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

9. A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

10. Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

11. Claims 1-5, 10-13, 15, 18, 26, and 28 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 46 of copending Application No. 10/268,132, RamachandraRao et al. (Applicants' Amendment, filed Dec. 22, 2004), in view of Hacker et al. (U.S. Patent Appl. Pub. No. 2004/0013858). This is a provisional obviousness-type double patenting rejection.

12. As to claim 1, RamachandraRao claims a method comprising: forming an interlayer dielectric (claim 46, page 8, line 5); etching a via and a trench in the interlayer dielectric (claim 46, page 8, line 6); exposing the dielectric to a sealant chain having at least silicon, carbon, oxygen, and hydrogen (claim 46, page 8, line 7-8).

13. RamachandraRao does not expressly claim a porous dielectric. Hacker teaches that materials with a low dielectric constant are essential for reducing interconnect delays (paragraph 0002). Moreover, porous silicia is a commonly used low dielectric material (paragraph 0004). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a porous dielectric. One who is skilled in the art would be motivated to use a porous dielectric for its lower dielectric constant, to reduce device interconnect delays.

14. RamachandraRao does not expressly claim that the sealant chain reacts with a second chain, that has at least oxygen and is present in the interlayer dielectric defining the pores, to form a continuous layer over the surface of the interlayer dielectric. Hacker further teaches that porous organic dielectric films are vulnerable to plasma damage, and upon etching, Si-OH or silanol remains on the dielectric, where the

organic group formerly resided (paragraph 0019). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to react a sealant chain with a second chain, that has at least oxygen and is present in the interlayer dielectric defining the pores, to form a continuous layer over the surface of the interlayer dielectric. One who is skilled in the art would be motivated to use a porous dielectric, due to its lower dielectric constant, and to perform conventional plasma etching on the porous dielectric. Moreover, one who is skilled in the art would motivated to fill the porous material by chemically bonding the sealant chain to a Si-OH compound, a remnant of plasma etching.

15. As to claim 2, Hacker discloses that the interlayer dielectric is an oxide (paragraph 0004).

16. As to claim 3, RamachandraRao claims that the sealant chain comprises an alkoxysilane (claim 50, page 9, lines 1-4).

17. As to claim 4, Hacker discloses that the second chain contains at least Si-OH (paragraph 0019).

18. As to claim 5, Hacker discloses that the interlayer dielectric is a polymer (paragraph 0005).

19. As to claim 10, RamachandraRao claims the sealant chain uses an oligomeric structure (claim 50, page 9, lines 1-4).

20. As to claim 11, RamachandraRao claims a method comprising: etching a via and a trench in a dielectric (claim 46, page 8, line 6); treating the surface of the dielectric with a silane coupling reagent (claim 46, page 8, line 7-8).

21. RamachandraRao does not expressly claim a porous dielectric. Hacker teaches that materials with a low dielectric constant are essential for reducing interconnect delays (paragraph 0002). Moreover, porous silicia is a commonly used low dielectric material (paragraph 0004). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a porous dielectric. One who is skilled in the art would be motivated to use a porous dielectric for its lower dielectric constant, to reduce device interconnect delays.

22. RamachandraRao does not expressly claim forming a conductive layer on the surface of the dielectric. Hacker teaches treating the surface of a porous dielectric with a silane coupling reagent for fabricating a dual damascene trench structure (paragraph 0108), including forming conductive layer (90) on the surface of the dielectric (20) (paragraph 0111; Figure 1C). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a conductive layer on the surface of the dielectric. One who is skilled in the art would be motivated to form a completed dual damascene trench structure.

23. As to claim 12, Hacker discloses that the dielectric is an oxide (paragraph 0004).

24. As to claim 13, RamachandraRao claims that the silane coupling reagent comprises an alkoxysilane (claim 50, page 9, lines 1-4).

25. As to claim 15, Hacker discloses that the interlayer dielectric is a polymer (paragraph 0005).

26. As to claim 18, RamachandraRao claims that the silane coupling reagent comprises an oligomeric structure (claim 50, page 9, lines 1-4).

27. As to claim 26, RamachandraRao does not expressly claim that the dielectric comprises an oxide. Hacker teaches that materials with a low dielectric constant are essential for reducing interconnect delays (paragraph 0002). Moreover, silicia is a commonly used low dielectric material (paragraph 0004). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use an oxide. One who is skilled in the art would be motivated to use an oxide for its lower dielectric constant, to reduce device interconnect delays.

28. As to claim 28, RamachandraRao does not expressly claim that the dielectric is a polymer. Hacker teaches that materials with a low dielectric constant are essential for reducing interconnect delays (paragraph 0002). Moreover, polymers are commonly used low dielectric materials (paragraph 0005). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a polymer. One who is skilled in the art would be motivated to use a polymer for its lower dielectric constant, to reduce device interconnect delays.

29. Claims 6, 16-17, and 19 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 46 of copending Application No. 10/268,132, RamachandraRao et al., in view of Hacker, in further view of Komatsu et al. (U.S. Patent No. 6,451,436).

30. As to claim 6, RamachandraRao does not expressly claim that the sealant chain comprises an alkoxyvinylsilane. However, Komatsu discloses a method for forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxyvinylsilane

composition (column 4, lines 6-23, lines 29-30). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a sealant chain comprising an alkoxyvinylsilane. One who is skilled in the art would be motivated to use alkoxyvinylsilane to fill the pores with a silicon-containing material with a low dielectric constant with excellent adhesion and strength.

31. As to claim 16, RamachandraRao does not expressly claim that the silane coupling reagent comprises a alkoxyvinylsilane. However, Komatsu discloses a method for forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxyvinylsilane composition (column 4, lines 6-23, lines 29-30). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a silane coupling reagent comprising a alkoxyvinylsilane. One who is skilled in the art would be motivated to use alkoxyvinylsilane to fill the pores with a silicon-containing material with a low dielectric constant with excellent adhesion and strength.

32. As to claim 17, Komatsu discloses that the alkoxyvinylsilane is vinyltriethoxysilane (column 4, lines 29-30).

33. As to claim 19, Komatsu discloses that the oligomeric structure is a dimer (column 4, lines 6-23).

34. Claims 25, 27, and 32 are provisionally rejected under the judicially created doctrine of double patenting over claims 46 and 50 of copending Application No. 10/268,132, RamachandraRao et al. (Applicants' Amendment, filed Dec. 22, 2004).

35. As to claim 25, RamachandraRao claims a method comprising: forming a dielectric (claim 46, page 8, line 5); and exposing the surface of the dielectric to a silane coupling reagent, wherein the silane coupling reagent reacts with the dielectric to form a continuous film over the dielectric (claim 46, page 8, lines 7-10). Although the conflicting claims are not identical, they are not patentably distinct from each other because Applicants' claim 25 is generic to all that is recited in claim 46 of RamachandraRao in Application No. 10/268,132. That is, claim 46 of RamachandraRao falls entirely within the scope of Applicants' claim 25 or, in other words, Applicants' claim 25 is anticipated by claim 46 of RamachandraRao. Specifically, RamachandraRao's claim 46 contains additional limitations, such as forming an antireflective coating (claim 46, page 8, line 5); etching (claim 46, page 8, line 6); and selectively passivating (claim 46, page 8, lines 9-10) which are not claimed by the Applicants.

36. As to claim 27, RamachandraRao claims that the silane coupling reagent comprises a trialkoxysilane (claim 50, page 9, lines 1-4).

37. As to claim 32, RamachandraRao claims that the silane coupling reagent comprises an oligomeric structure (claim 50, page 9, lines 1-4).

Claim Rejections - 35 USC § 102

38. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –

> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

39. Claims 1-5, 7-8, 10-13, 15, 18-19, 25-28, and 32 are rejected under 35 U.S.C. 102(e) as being anticipated by RamachandraRao (U.S. Patent Appl. Pub. No. 2004/0072436).

40. The applied reference has a common assignee with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

41. As to claim 1, RamachandraRao discloses a method comprising: forming a porous interlayer dielectric (302) (paragraphs 0029, 0032; Figure 3); etching a via and a trench in the porous interlayer dielectric (paragraph 0044; Figure 7); exposing the dielectric to a sealant chain having at least silicon, carbon, oxygen, and hydrogen (paragraph 0037), wherein the sealant chain reacts with a second chain, that has at least oxygen and is present in the interlayer dielectric defining the pores, to form a continuous layer over the surface of the interlayer dielectric (paragraph 0047).

42. As to claim 2, RamachandraRao discloses that the interlayer dielectric (302) is an oxide (paragraph 0032).

43. As to claim 3, RamachandraRao discloses that the sealant chain comprises an alkoxysilane (paragraph 0037).

44. As to claim 4, RamachandraRao discloses that the second chain contains at least Si-OH (paragraph 0047).

45. As to claim 5, RamachandraRao discloses that the interlayer dielectric is a polymer (paragraph 0035).

46. As to claim 7, RamachandraRao discloses that the second chain contains at least C-OH (paragraph 0047).

47. As to claim 8, RamachandraRao discloses that the second chain contains at least C=O (paragraph 0047).

48. As to claim 10, RamachandraRao discloses that the sealant chain uses an oligomeric structure (paragraph 0037).

49. As to claim 11, RamachandraRao discloses a method comprising: etching a via and a trench in a dielectric (paragraph 0044; Figure 7), wherein the dielectric (302) has a plurality of pores (paragraphs 0029, 0036); treating the surface of the dielectric with a silane coupling reagent to seal the pores exposed on the surface of the dielectric (paragraph 0037); and forming a conductive layer (1002) on the surface of the dielectric (paragraph 0049; Figure 10).

50. As to claim 12, RamachandraRao discloses that the dielectric is an oxide (paragraph 0032).

51. As to claim 13, RamachandraRao discloses that the silane coupling reagent comprises an alkoxysilane (paragraph 0037).

52. As to claim 15, RamachandraRao discloses that the dielectric is a polymer (paragraph 0035).

53. As to claim 18, RamachandraRao discloses that the silane coupling reagent comprises an oligomeric structure (paragraph 0037).

54. As to claim 19, RamachandraRao discloses that the oligomeric structure is a dimer (paragraph 0037).

55. As to claim 25, RamachandraRao discloses a method comprising: forming a dielectric (302) (paragraphs 0029, 0036); and exposing the surface of the dielectric to a silane coupling reagent, wherein the silane coupling reagent reacts with the dielectric to form a continuous film over the dielectric (paragraph 0037).

56. As to claim 26, RamachandraRao discloses that the dielectric comprises an oxide (paragraph 0032).

57. As to claim 27, RamachandraRao discloses that the silane coupling reagent comprises a trialkoxysilane (paragraph 0037).

58. As to claim 28, RamachandraRao discloses that the dielectric is a polymer (paragraph 0035).

59. As to claim 32, RamachandraRao discloses that the silane coupling reagent comprises an oligomeric structure (paragraph 0037).

60. Claims 11-12 and 25-26 are rejected under 35 U.S.C. 102(e) as being anticipated by Catabay et al. (U.S. Patent No. 6,537,896).

61. As to claim 11, Catabay discloses a method comprising: etching a via and a trench (40) in a dielectric (20), wherein the dielectric has a plurality of pores (22)

(column 7, lines 10-15; Figure 5); treating the surface of the dielectric with a silane coupling reagent (column 5, lines 32-38) to seal the pores exposed on the surface of the dielectric (150) (column 7, lines 17-19); and forming a conductive layer on the surface of the dielectric (column 7, lines 19-26).

62. As to claim 12, Catabay discloses that the dielectric is an oxide (column 3, lines 26-29).

63. As to claim 25, Catabay discloses a method comprising: forming a dielectric (20) (column 7, lines 8-9); and exposing the surface of the dielectric to a silane coupling reagent (column 5, lines 32-38), wherein the silane coupling reagent reacts with the dielectric to form a continuous film over the dielectric (150) (column 7, lines 17-19).

64. As to claim 26, Catabay discloses that the dielectric comprises an oxide (column 3, lines 26-29).

Claim Rejections - 35 USC § 103

65. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

66. Claims 1-2, 4-5, and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Catabay in view of Hacker et al. (U.S. Patent Appl. Pub. No. 2004/0013858).

67. As to claim 1, Catabay discloses a method comprising: forming a porous interlayer dielectric (20) (column 7, lines 9-10; Figure 5); etching a via and a trench (40) in the porous interlayer dielectric (20) (column 7, lines 10-15); exposing the dielectric to a sealant chain having at least silicon, carbon, oxygen, and hydrogen (column 7, lines 38-42).

68. Catabay does not expressly disclose that the sealant chain reacts with a second chain, that has at least oxygen and is present in the interlayer dielectric defining the pores, to form a continuous layer over the surface of the interlayer dielectric. Hacker teaches that nanoporous silicia has a lower dielectric constant (paragraph 0004) and organic materials are common nonporous dielectric materials (paragraph 0005). A low dielectric constant material is essential for reducing interconnect delays (paragraph 0002). Moreover, Hacker teaches, porous organic dielectric films are vulnerable to plasma damage, and upon etching, Si-OH or silanol remains on the dielectric, where the organic group formerly resided (paragraph 0019). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to react a sealant chain with a second chain, that has at least oxygen and is present in the interlayer dielectric defining the pores, to form a continuous layer over the surface of the interlayer dielectric. One who is skilled in the art would be motivated to use a porous dielectric, due to its lower dielectric constant, and to perform conventional plasma etching on the porous dielectric. Moreover, one who is skilled in the art would motivated to fill the porous material by chemically bonding the sealant chain to a Si-OH compound, a remnant of plasma etching.

69. As to claim 2, Catabay discloses that the dielectric is an oxide (column 3, lines 26-29).

70. As to claim 4, Hacker discloses that the second chain contains at least Si-OH (paragraph 0019).

71. As to claim 5, Hacker discloses the interlayer dielectric is a polymer (paragraph 0005).

72. As to claim 9, Catabay discloses that the continuous layer comprises SiO_2 (column 7, lines 38-42; column 2, lines 29-32).

73. Claims 3, 6, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Catabay, in view of Hacker, in further view of Komatsu.

74. As to claim 3, Catabay does not expressly disclose that the sealant chain comprises an alkoxysilane. However, Komatsu discloses a method for forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxysilane composition (column 4, lines 6-23). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a sealant chain comprising an alkoxysilane. One who is skilled in the art would be motivated to use alkoxysilane to fill the pores with a silicon-containing material with a low dielectric constant with excellent adhesion and strength.

75. As to claim 6, Komatsu discloses that the sealant chain comprises an alkoxyvinylsilane (column 4, lines 6-23, lines 29-30).

76. As to claim 10, Komatsu discloses that the sealant chain uses an oligomeric structure (column 4, lines 6-23).

77. Claims 13, 15-19, and 27-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Catabay, in view of Komatsu.

78. As to claim 13, Catabay does not expressly disclose that the silane coupling reagent comprises an alkoxysilane. However, Komatsu discloses a method for forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxysilane composition (column 4, lines 6-23). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a silane coupling reagent comprises an alkoxysilane. One who is skilled in the art would be motivated to use alkoxysilane to fill the pores with a silicon-containing material with a low dielectric constant with excellent adhesion and strength.

79. As to claim 15, Catabay does not expressly disclose that the dielectric is a polymer. However, Komatsu teaches that polymer dielectrics have a lower dielectric constant of less than 3 (column 1, lines 51-58) to lower the overall capacitance of the electrical interconnect (column 2, lines 7-9). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a polymer dielectric. One who is skilled in the art would be motivated to use a material with a lower dielectric constant, to lower the overall capacitance of the interconnect structure.

80. As to claim 16, Catabay does not expressly disclose that the silane coupling reagent comprises an alkoxyvinylsilane. However, Komatsu discloses a method for

forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxyvinylsilane composition (column 4, lines 6-23). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a silane coupling reagent comprises an alkoxyvinylsilane. One who is skilled in the art would be motivated to use alkoxyvinylsilane to fill the pores with a silicon-containing material with a low dielectric constant with excellent adhesion and strength.

81. As to claim 17, Komatsu discloses that the alkoxyvinylsilane is vinyltriethoxysilane (column 4, lines 29-30).

82. As to claim 18, Komatsu discloses that the silane coupling reagent comprises an oligomeric structure (column 4, lines 6-23).

83. As to claim 19, Komatsu discloses that the oligomeric structure is a dimer (column 4, lines 6-23).

84. As to claim 27, Komatsu discloses that the silane coupling reagent comprises a trialkoxysilane (column 4, lines 6-23).

85. As to claim 28, Catabay does not expressly disclose that the dielectric is a polymer. However, Komatsu teaches that polymer dielectrics have a lower dielectric constant of less than 3 (column 1, lines 51-58) to lower the overall capacitance of the electrical interconnect (column 2, lines 7-9). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a polymer dielectric. One who is skilled in the art would be motivated to use a material with a lower dielectric constant, to lower the overall capacitance of the interconnect structure.

86. As to claim 29, Catabay does not expressly disclose that the silane coupling reagent comprises trialkoxyvinylsilane. However, Komatsu discloses a method for forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxyvinylsilane composition, including trialkoxyvinylsilane (column 4, lines 6-23). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a silane coupling reagent comprising trialkoxyvinylsilane. One who is skilled in the art would be motivated to use trialkoxyvinylsilane to fill the pores with a silicon-containing material with a low dielectric constant with excellent adhesion and strength.

87. As to claim 30, Catabay discloses exposing the dielectric to an oxidant to prepare the surface of the dielectric (column 7, lines 38-42).

88. As to claim 31, Catabay discloses that the oxidant comprises peroxide (column 7, lines 38-42).

89. As to claim 32, Komatsu discloses that the silane coupling reagent comprises an oligomeric structure (column 4, lines 6-23).

90. Claims 21-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Catabay, in view of Yau et al. (U.S. Patent No. 6,054,379).

91. As to claim 21, Catabay does not expressly disclose that treating comprises bubble vapor deposition of the silane coupling reagent. Yau discloses a method of forming a barrier layer for porous low k dielectric layers with a silane based compound (column 2, lines 46-54). Moreover, Yau teaches delivering the silane based process gas through vaporization from a liquid precursor and an adding an inert delivery gas

(column 9, lines 2-12). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to treat by bubble vapor deposition of the silane coupling reagent. One who is skilled in the art would be motivated to use bubble vapor deposition, because this method has been used successfully in forming a barrier layer for a porous low k dielectric.

92. As to claim 22, Yau discloses that the bubble-vapor deposition carrier gas comprises Nitrogen (N_2) (column 8, lines 62-63; column 10, lines 61-62).

93. As to claim 23, Yau discloses that the bubble-vapor deposition carrier gas comprises Argon (column 8, lines 62-63; column 10, lines 61-62).

94. As to claim 24, Catabay does not expressly disclose that treating comprises spin-coating the silane coupling reagent onto the dielectric. Yau discloses a method of forming a barrier layer for porous low k dielectric layers with a silane based compound (column 2, lines 46-54). Moreover, Yau teaches depositing the barrier layer by spin coating silane the based compound, a technique which is self-planarizing (column 10, lines 31-35). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to spin-coating the silane coupling reagent onto the dielectric. One who is skilled in the art would be motivated to spin coat, because this method has been used successfully in forming a self-planarizing barrier layer for a porous low k dielectric.

95. Claims 14 and 33-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Catabay, in view of Komatsu, in further view of Kloster et al. (U.S. Patent Appl. Pub. No. 2004/0214427).

96. As to claim 14, Catabay does not expressly disclose that the alkoxysilane is methoxypropyltrimethoxysilane. Komatsu discloses a method for forming a silicon-containing film with a low dielectric constant as low as 3 with excellent substrate adhesion and film strength (column 2, lines 56-60), using an alkoxysilane composition (column 4, lines 6-23). Kloster teaches the use of methoxypropyltrimethoxysilane as a pore filling agent for porous dielectrics (paragraph 0033). Moreover, Kloster teaches that methoxypropyltrimethoxysilane is effective at sealing pores (paragraph 0033) by effectively attaching to the sidewalls within the pores (paragraph 0030). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use methoxypropyltrimethoxysilane. One who is skilled in the art would be motivated to use an alkoxysilane composition that effectively fills pores.

97. As to claim 33, Kloster discloses that the continuous film comprises an SiO_2 film covalently linked to the porous dielectric (paragraph 0033).

98. As to claim 34, Kloster discloses that a plurality of Si-OCH_3 groups condense on the porous dielectric (paragraph 0033).

Allowable Subject Matter

99. Claim 20 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

100. The following is a statement of reasons for the indication of allowable subject matter for claim 20: the prior art fails to teach or suggest that the oligomeric structure is

designed to fill a pore with one atom. The closest prior art, Catabay discloses a method comprising: etching a via and a trench (40) in a dielectric (20), wherein the dielectric has a plurality of pores (22) (column 7, lines 10-15; Figure 5); treating the surface of the dielectric with a silane coupling reagent (column 5, lines 32-38) to seal the pores exposed on the surface of the dielectric (150) (column 7, lines 17-19); and forming a conductive layer on the surface of the dielectric (column 7, lines 19-26). Moreover, Komatsu teaches that the silane coupling reagent comprises an oligomeric structure (column 4, lines 6-23). However, there is no motivation or suggestion that the oligomeric structure is designed to fill a pore with one atom, as in the context of claim 20.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eric B. Chen whose telephone number is (571) 272-2947. The examiner can normally be reached on Monday through Friday, 8AM to 4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G. Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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EBC EBC
May 20, 2005

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER